TwiNSol-CECs

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1st TwiNSol-CECs Workshop

Advance multicompound analyses and novel solutions for protection of environmental resources with contaminants of emerging concern in focus

Book of Abstracts

University of Novi Sad
Faculty of Technology Novi Sad
Novi Sad, Serbia

20-21 October 2022

TwiNSol-CECs
GA101059867
TWINNING FOR EXCELLENCE IN ENVIRONMENTAL RESOURCES PROTECTION

Funded by the European Union

BOOK OF ABSTRACTS

1st TwiNSol-CECs Workshop

Advance multicompound analyses and novel solutions for protection of environmental resources with contaminants of emerging concern in focus

University of Novi Sad, Faculty of Technology Novi Sad (TFNS), Novi Sad, Serbia, 20-21 October 2022

UNIVERSITY OF NOVI SAD
FACULTY OF TECHNOLOGY
NOVI SAD

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FACULTY OF TECHNOLOGY NOVI SAD

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Dear colleagues, participants of the 1st TwiNSol-CECs Workhop,

On behalf of the TwiNSol-CECs team I would like to welcome you all to the first event in a series of events planned within the TwiNSol-CECs project (GA 101059867). I would also like to thank you for all of your contributions in the form of oral and poster presentations, with the abstracts gathered in this Book of Abstracts accessible via the project website (www.twinsol-cec.com). We are really proud to have won this project in the framework of Horizon Europe and honoured to have this and many more opportunities to share knowledge and exchange ideas within the domain of environmental research.

The aim of this event is to gather scientists and experts interested in, but not limited to, problems of contaminants of emerging concern (CECs) occurrence in the environment and relevant analytical methods, as well as novel solutions for their removal. The Workshop will also go beyond these topics as it will serve as a forum for exchange of project ideas and results in the domain of environmental protection, contributing to the harmonization of research and innovation efforts important for the sustainable transition of whole Europe, as foreseen by the European Green Deal, towards zero-pollution, i.e. toxic free environment. A session dedicated to the ongoing EU funded Twinning projects at the Serbian universities is a part of the Workshop agenda, in addition to the presentations of the scientific results of the registered participants. The session is of two-fold importance: to share information on the latest research developments in Serbia, recognized as “excellence pockets” by the European Commission, and to promote the Twinning calls as a way of boosting institutional research capacities.

TwiNSol-CECs team wishes you all a pleasant stay in Novi Sad, hoping for fruitful discussions on new research ideas and collaboration for better toxic-free common future,

Prof. Dr. Nataša Đurišić-Mladenović
Chair

TwiNS-CECs
GA101059867
TWINNING FOR EXCELLENCE IN ENVIRONMENTAL RESOURCES PROTECTION

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PROGRAM

UNIVERSITY OF NOVI SAD
FACULTY OF TECHNOLOGY
NOVI SAD

1st TwiNSol-CECs Workshop

Advance multicompound analyses and novel solutions for protection of environmental resources with contaminants of emerging concern in focus

University of Novi Sad, Faculty of Technology Novi Sad (TFNS), Novi Sad, Serbia, 20-21 October 2022

Agenda

20 Oct 2022

9,00-15,00	Registration at the Faculty of Technology Novi Sad, Entrance Hall (Bulevar cara Lazara 1)
	Joint morning session of the 1st TwiNSol-CECs Workshop and 2nd ICAPP, **University of Novi Sad Rectorate building, Amphitheater** (Dr Zorana Đinđića 1)
10,45-12,15	Official opening
	Plenary lectures
12,15-12,45	João G. Crespo: **Membranes in Bioprocessing**
12,30-13,00	*Coffee break*
13,00-13,30	Marinella Farré, Marta Llorca, Katerina Savva, Albert Vega: **The challenge of assessing contaminants of emerging concern in the environment**
13,30-14,00	*TwiNSol-CECs Networking with coffee* – Exploring further project endevours
14,00-15,00	*Lunch break*

Afternoon session, **Faculty of Technology, Blue Hall** (Bulevar cara Lazara 1)
Invited lectures on TWINNING projects in domain of environmental research
Chairs: Vladimir Beškoski and Nataša Đurišić-Mladenović

15,00-15,20 Nataša Đurišić-Mladenović, Zita Šereš, Biljana Pajin, Jelena Živančev, Nikola Maravić, Igor Antić, TFNS: **Twinning for excellence in protection of environmental resources: TwiNSol-CECs**

15,20-15,40 Biljana Basarin, Faculty of Science, Novi Sad: **EXTREMECLIMTWIN – Extremely important linking for excelence in hydroclimate research**

15,40-16,00 Snežana Maletić, Faculty of Science, Novi Sad: **Twinning excellence on organic soil amendments effect on nutrient and contaminant dynamics in the subsurface, TwinSubDyn**

16,00-16,20 Vladimir Beškoski, Faculty of Chemistry, Belgrade: **Twinning to address the PFAS challenge in Serbia – PFAStwin**

16,20-16,35 *Coffee break*

16,35-16,55 Đurđa Kerkez, Faculty of Science, Novi Sad: **Twinning for smart water – thinking and rethinking wastewater management in circular economy frame (SmartWaterTwin)**

16,55-17,15 Dragana Miladinović, Ankica Kondić-Špika, Tijana Zeremski, Sandra Cvejić, Sonja Gvozdenac, Boško Dedić, Siniša Jocić, Aleksandra Radanović, Ana Marjanović-Jeromela, et al., Institute of Field and Vegetable Crops, National Institute of Republic of Serbia, Novi Sad: Institute of Field and Vegetable Crops: **CROPINNO - Stepping up scientific excellence and innovation capacity for climate-resilient crop improvement and production**

Invited lectures on topics of TwiNSol-CECs interest
Chairs: Jelena Živančev and Vesna Vasić

17,15-17,40 Szabolcs Kertész, Gabriella Huszár, Balázs Szegedi, József R. Lennert, József Csanádi, Nikolett Sz. Gulyás, Zsuzsanna László, Gábor Veréb, Sándor Beszédes, Cecilia Hodúr, **Opportunities and challenges for membrane separation process intensification**

Oral presentation of registered participants

17,40-17,55 Marija B. Ljević, Branka D. Lončarević, Vladimir P. Beškoski, **Application of respirometry and comprehensive two-dimensional gas chromatography in biodegradation studies**

21 Oct 2022

9,00-10,00 Registration at the Faculty of Technology Novi Sad, Entrance Hall (Bulevar cara Lazara 1)

Morning session, **Faculty of Technology, Blue Hall** (Bulevar cara Lazara 1)
Invited lectures on topics of TwiNSol-CECs interest
Chairs: Marijana Dragosavac and Ivica Strelec

10,00-10,25 Jelena Živančev, Igor Antić, Maja Buljovčić, Dušan Rakić, Nataša Đurišić-Mladenović, **Analysis of CECs in the environment of Western Balkans**

10,25-10,50 Sanja Panić, Mirjana Petronijević, Nataša Đurišić-Mladenović: **The development strategies for nano-engineered heterogeneous catalysts for wastewater treatment – towards greener approach**

10,50-11,15 Sandra Budžaki, Zita Šereš, Ivica Strelec*:* **Immobilization of lipases on functionalised carriers produced from selected agro-food industrial waste**

11,15-11,30 *Coffee break*

11,30-11,55 Nikola Maravić, Zita Šereš, Biljana Pajin, Dragana Šoronja Simović, Nataša Đurišić-Mladenović, Jelena Šurlan, **Membrane technologies in water treatment**

11,55-12,20 Vesna Vasić, Dragana Kukić, Marina Šćiban: **Biomaterials in water and wastewater treatment**

Oral presentation of registered participants

12,20-12,35 Marijana Dragosavac, **Bespoke particles for purification and separation manufactured via membrane emulsification**

12,35-12,50 Dragana, B, Ljubojević Pelić, Nikolina, J, Novakov, Brankica, D, Kartalović, Jelena, M, Vranešević, Miloš, M, Pelić, Željko, A, Mihaljev, Milica, M. Živkov Baloš, **Emerging contaminants in aquatic ecosystem and their effects on fish and human health through the food web**

12,50-13,05 Nikolina, J, Novakov, Brankica, D, Kartalović, Dragana, B, Ljubojević Pelić, Jelena, M, Vranešević, Miloš, M, Pelić, **Use of purified wastewater from slaughterhouse and farm industries in aquaculture and agriculture**

13,05-14,30 Lunch break

Afternoon session, **Faculty of Technology, Central Lobby** (Bulevar cara Lazara 1)

14,30-16,30 Poster presentations with coffee (set-up 11,15-11,40, dismatling:16,30-17,00)

P1 ANALYSIS OF BIODEGRADATION PRODUCTS FROM BIOPLASTICS BY LC-HRMS,
Katerina Savva, Maria Fernandez-Altimira, Maria Vila, Marinella Farré, Marta Llorca

P2 SYNTHESIS AND CHARACTERIZATION OF MAGNETITE-BIOCHAR COMPOSITE AS A POTENTIAL ADSORBENT FOR WASTEWATER TREATMENT,
Mirjana Petronijević, Sanja Panić, Saša Savić, Sanja Petrović, Nataša Đurišić-Mladenović

P3 APPLICABILITY OF LIFE CYCLE IMPACT ASSESSMENT METHODOLOGIES: DESIGN OF NATURE BASED SOLUTIONS FOR WATER DECONTAMINATION,

Sanja Radovic, Maja Turk Sekulic, Sabolc Pap, Boris Agarski, Djordje Vukelic, Jelena Radonic, Jelena Prodanovic

P4 IS THERE A SHARP DIFFERENCE BETWEEN THE DEFINITIONS "COMPOUNDS OF EMERGING CONCERNS" AND "ENDOCRINE-DISRUPTING COMPOUNDS"?

Igor Antić, Jelena Živančev, Maja Buljovčić, Dušan Rakić, Nataša Đurišić-Mladenović

P5 OCCURRENCE AND FATE OF PHARMACEUTICALS IN SPANISH INTERMITTENT STREAMS,

Olga Gómez-Navarro, Nicola Montemurro, Sandra Pérez

P6 PRESENCE OF CECs IN CROPS AFTER IRRIGATION WITH CONTAMINATED WATER USING HRMS, Nicola Montemurro, Sandra Perez Solsona

P7 BLACKBERRY STEM LIGNIN AS A BIOSORBENT FOR REMOVAL OF Cr(VI) IONS FROM WASTEWATER,

Vesna, M. Vasić, Dragana V. Kukić, Marina B. Šćiban, Mirjana G. Antov, Jorge Gominho, Ana Lourenço, Ricardo A. Costa, Duarte M. Neiva

P8 MICROPLASTICS AS A VECTOR OF POLLUTION WITH PERSISTENT ORGANIC POLLUTANTS,

Brankica D.Kartalovic, Jelena M. Vranešević, Dušan S.Lazic, Nikolina J. Novakov , Krešimir M. Mastanjević, Kristina J. Habschied

P9 WATER REGULATIONS, TREATMENT OF INDUSTRIAL WASTEWATER AND PROBLEMS IN PRACTICE, Žužana Šandor Milošević

P10 PAHs ORIGINATING FROM TRADITIONAL SMOKEHOUSES AND THEIR EFFECT ON ENVIRONMENT AND HUMAN HEALTH,

Jelena M. Vranešević, Brankica D. Kartalović, Nikolina J. Novakov, Snezana Škaljac, Suzana L. Vidaković Knežević, Miloš M. Pelić, Dragana B. Ljubojević Pelić

P11 APPLICATION OF ORGANIC ACTIVATED BENTONITE IN THE TREATMENT OF AMMONIA-PHENOL WASTEWATER,

Hana Alihodžić, Abdel Đozić, Melisa Ahmetović, Indira Šestan, Sabina Begić, Mirnesa Zohorović, Halid Junuzović

P12 APPLICATION OF RAW BENTONITE IN THE TREATMENT OF AMMONIA-PHENOL WASTEWATER,

Abdel Đozić, Hana Alihodžić, Halid Junuzović, Indira Šestan, Sabina Begić, Mirnesa Zohorović, Melisa Ahmetović

16,30-16,45 Certificate awarding and concluding remarks (Blue Hall)

PLENARY LECTURES

Prof. João G. Crespo, Professor of Chemical Engineering at the School of Science and Technology –NOVA University of Lisbon, Portugal. Director of the Laboratory of Membrane Processes at iBET. Coordinator of the research centre LAQV at NOVA University of Lisbon (Sustainable Chemistry; the largest research centre in Portugal). Former Vice-Rector for Research and Innovation and former Coordinator of NOVA Doctoral School. Co-founder of the spin-off company"Zeyton Nutraceuticals". Member of the Portuguese Academy of Engineering. Honorary member of the European Membrane Society. Research Keywords: Membrane materials and processes; Bioseparations; Water treatment and valorisation of bioresources; Process Monitoring using molecular probes. **Lecture on: Membranes in bioprocessing**

Marinella Farré, PhD, Principal Research Fellow at the Institute of Environmental Assessment and Water Research (IDAEA) belonging to the Spanish National Research Council (CSIC) (Spain) and one of the group leaders of the ON HEALTH research group. Her research focuses on the investigation of contaminants of emerging concern in the environment, food and humans, on the development and application of new analytical approaches by liquid and gas chromatography coupled to advanced mass spectrometry, as well as in the development and application of biological techniques, such as immunoassays and biosensors. Coordinator of the JPI-Water FOREWARN, and the national project IMAGE and she is IP in international projects EUROqCHARM, EXaMINA, TwiNSol-CECs, PARC and PROMISCES. **Lecture on: The challenge of assessing contaminants of emerging concern in the environment**

MEMBRANES IN BIOPROCESSING

João G. Crespo

LAQV-Requimte, Department of Chemistry, FCT - NOVA University of Lisbon, Campus de Caparica, 2829-516 Caparica, Portugal, jgc@fct.unl.pt

This lecture discusses how different membrane functionalities impact on their performance. Similarly, to biological membranes, synthetic membranes may be designed in order to organize the physical space, allowing for defining different “compartments” and regulating the transport of diverse (bio)chemical species between them. This permselectivity behavior results from specific functionalities of membranes, which may be achieved by designing their morphology, chemical character and topography. Transport regulation may be achieved by making use of different mechanisms – size exclusion, electrostatic interactions, affinity interactions -, that determine the rate of selective transport of different species. This lecture discusses the structure-function relation in synthetic membranes and how this relation can be used in favor of specific membrane processes. Different case-studies will be discussed, namely for membrane bioreactors targeting specific solutes and for membrane contactors regulating the transport of ionic species. The use of membrane contactors in order to induce protein crystallization will be discussed. The relevance of membrane monitoring using molecular probes will be also addressed for the monitoring of local oxygen concentration and temperature, making possible to acquire concentration and temperature profiles inside membranes and/or at their surface. Finally, the need for membranes that after being used and disposed can be easily biodegraded, avoiding the accumulation of synthetic polymers in landfills, with potential contamination of soils and water bodies, will be addressed. The development of biopolymeric membranes, that should be sufficiently stable to assure a prolonged operating lifetime but, simultaneously, easy to degrade when disposed will be discussed.

Keywords: Membrane, Transport regulation, Monitoring, Biopolymeric

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THE CHALLENGE OF ASSESSING CONTAMINANTS OF EMERGING CONCERN IN THE ENVIRONMENT

***Marinella Farré*, Marta Llorca, Katerina Savva, Albert Vega**

*ON HEALTH research group, Institute of Environmental Assessment and Water Research (IDAEA-CSIC), C/Jordi Girona, 18-26, 08034 Barcelona, Catalonia, Spain, *mfuqam@cid.csic.es*

The list of contaminants of emerging concern (CECs) has steadily increased during the last decades including a broad spectrum of organic and inorganic compounds showing different physicochemical and toxicological properties. Some of the more prominent groups include persistent and mobile organic compounds (PMOCs), polar pesticides, pharmaceuticals, flame retardants, a significant number of chemical groups employed as plastic additives, personal care products, anthropogenic particles including nanomaterials and micro-and nano plastics, among others. For the analysis of organic chemicals liquid chromatography separations coupled with mass spectrometry analysers (LC-MS), have been the techniques of choice for environmental analysis. Nowadays, thanks to its unique ability to measure analytes based on accurate mass, full-spectrum high-resolution mass spectrometry (HRMS) can simultaneously gain qualitative and quantitative information on a virtually unlimited number of analytes.
In this presentation, several examples of the analysis of CECs in the different environmental compartments using targeted, non-targeted and suspected screening approaches will be presented.

Keywords: environmental samples, LC-MS, PFASs, nanomaterials, natural toxins, micro-nano plastics

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INVITED LECTURES

TWINNING FOR EXCELLENCE IN PROTECTION OF ENVIRONMENTAL RESOURCES: TwiNSol-CECs

***Nataša Đurišić-Mladenović**, Zita Šereš, Biljana Pajin, Jelena Živančev, Nikola Maravić, Igor Antić*

University of Novi Sad, Faculty of Technology Novi Sad, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia,
**natasa.mladenovic@uns.ac.rs*

European Commission recognizes the need for harmonizing the research capacities throughout the entire continent and call for improving research management capacities in the so-called Widening Countries and Outermost Regions, as a means to reverse growing disparity between countries and regions in terms of R&I performance, which ultimatively effects the position of EU as a global leader in research and innovation. Within the Horizon Europe (HE) call for Twinning Western Balkans, Faculty of Technology Novi Sad (TFNS) recognized an opportunity to strengthen the existing institutional resources already proven within the domain of environmental research and to boost them through twinning with two prestigeous, top-leading research institutions from EU Members States under umbrella of TwiNSol-CECs project. Being among the leading academic players in Serbia and Western Balkans that has been involved in several preliminary monitoring studies of different trace contaminants in the environment and food, including target analysis of some chemical classes belonging to contaminants of emerging concern (CECs), TFNS will strive to reinforce the capacities in innovative CECs analysis and removal methodologies through TwiNSol-CECs collaboration and trainings with Spanish National Research Council, Institute of Environmental Assessment and Water Research (CSIC), Barcelona, Spain, and NOVA University Lisbon, NOVA School of Science and Technology (UNL), Lisbon, Portugal. Surveillance of CECs, as well as development and improvement of methods for their removal, has important roles in protection of both humans and the environmental resources. Thus, the general goal of TwiNSol-CECs is to raise the TFNS scientific and innovation excellence in various aspects of CECs research integrated in broader EU networks of excellence, contributing to national and regional scientific and economic growth and well-being and to the harmonization of advanced research and innovation efforts important for the overall faster and sustainable transition of whole Europe foreseen by European Green Deal (EGD) towards zero-pollution, toxic free environment. The presentation will give an overview of the project objectives in relation to the expected outcomes of the HE call, relevance to the strategic documents, and actuality within the research field.

Keywords: Contaminants of emerging concern, Environmental monitoring, Removal technologies, Horizon Europe

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EXTREMECLIMTWIN – EXTREMELY IMPORTANT LINKING FOR EXCELENCE IN HYDROCLIMATE RESEARCH

Biljana D. Basarin

University of Novi Sad, Faculty of Sciences, Department of Geography, Tourism and Hotel Management,

Trg Dositeja Obradovica 3, 21000 Novi Sad, biljana.basarin@gmail.com, biljana.basarin@dgt.uns.ac.rs

EXtremeClimTwin is a three-year project aimed at raising scientific excellence in the field of hydro-climate extremes in South East Europe. Through networking, knowledge transfer, and technical expertise, top research organizations from the EU, Climate Risk Analysis (CRA, Germany), Loughborough University, Department of Geography and Environment (LU, UK), and the Center for International Climate Research (CICERO, Norway) are assisting University of Novi Sad Faculty of Sciences (UNSPMF) in realizing its full scientific potential in the study of hydro-climatological extreme events. The EXtremeClimTwin project is also establishing the cooperative framework necessary for UNSPMF to advance and carry out its research on hydro-climate extremes.
The overall objective of EXtremeClimTwin is very relevant, now more than ever when Europe faces extremely high temperatures and unprecedented drought[1]. Nevertheless, the Western Balkans is predicted to become more vulnerable to climate change due to the climate change. In much of southeast Europe, a warmer climate is predicted to lead to more frequent and intense heat waves, less summer precipitation, and at the same time higher rainfall intensities (IPCC 2021[2]). Increasing heat extremes constitute a major risk for societies in southeast Europe. When combined with less summertime precipitation or drought, these factors can raise the danger of health hazards, have large impacts on agriculture. Moreover, increase in summertime energy consumption could lead to problems of energy security. UNSPMF recognized the need to build capacities in the detection and attribution of these extreme hydro-climate events through collaborations and training with institutions that have knowledge in this area of research. This goal is being achieved by Twinning with EU research-intensive institutions with strong expertise in the field.

Keywords: Twinning, heat wave, hydrological extreme

Acknowledgements: EXremeClimTwin has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952384

[1] https://edo.jrc.ec.europa.eu/documents/news/GDO-EDODroughtNews202207_Europe.pdf
[2] Allan, R. P., Hawkins, E., Bellouin, N., & Collins, B. (2021). IPCC, 2021: summary for Policymakers

TWINNING EXCELLENCE ON ORGANIC SOIL AMENDMENTS EFFECT ON NUTRIENT AND CONTAMINANT DYNAMICS IN THE SUBSURFACE, TwinSubDyn

Snežana SM. Maletić

University of Novi Sad, Faculty of Science, Trg Dositeja Obradović 3, 21000 Novi Sad,
snezana.maletic@dh.uns.ac.rs

TwinSubDyn aims to establish a research knowledge hub at University of Novi Sad, Faculty of Sciences (UNSPMF), Serbia, on the impacts of organic soil amendments on the fate of contaminant, and nutrient dynamics in the soil subsurface and implications for groundwater quality. The project will significantly boost research and innovation capacities of UNSPMF, through a twinning action with internationally leading research institutions in this research field from Europe: University of Vienna (UNIVIE), Forschungszentrum Jülich GmbH (FZJ), Martin Luther University Halle-Wittenberg (MLU) and Instituto de Recursos Naturales y Agrobiología de Sevilla (IRNAS-CSIC). The strategy for stepping up and stimulating scientific excellence and innovation capacity for our TwinSubDyn defined research topic is based on: Networking for Excellence, Establishment of long-lasting strategic partnerships with leading European research organizations; Raising the EU and global research profile of UNSPMF and its staff, Development of Science and Innovation Strategy, Spreading scientific knowledge; and finally Increasing overall competence via the strategic collaborative consortium TwinSubDyn research project and its intrinsic knowledge exchange and gains.

Keywords: Environment, Soil, Groundwater, Organic Amendments

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TWINNING TO ADDRESS THE PFAS CHALLENGE IN SERBIA – PFASTWIN

Vladimir P. Beškoski

University of Belgrade, Faculty of Chemistry, Studentski trg 12-16, 11000 Beograd, Serbia,
vbeskoski@chem.bg.ac.rs

Per- and polyfluoroalkyl substances (PFAS) are synthetic chemicals widely used for more than 60 years to make plastics, firefighting foams, and lubricants, and help create stain-resistant, waterproof, and nonstick products. However, as other anthropogenic chemicals they ended up in the environment and now can be found almost everywhere. They are detected in the soil, water, sediment, ice and snow. They are detected in the plants and other biota and accumulated trough the food chain finally they ended up in human bodies. Thus they represent a worldwide challenge of the 21st century.

National chemicals legislation of Republic of Serbia recognizes these chemicals. Unfortunately, only rare scientific or governmental institutions are capable to analyze these compounds. In addition, a solution to the challenge of remediation is not in sight, not only in Serbia, but worldwide. The project titled "Twinning to address the PFAS challenge in Serbia", whose acronym is PFAStwin, aims to enhance networking activities between University of Belgrade, Faculty of Chemistry – UBFC (one of the leading scientific institutions in Serbia), and two top-class counterparts, who are leaders in PFAS analysis (Institute of General Organic Chemistry (IQOG) of the Higher Council for Scientific Research (CSIC) from Spain) and innovative (bio)remediation of emerging pollutants (French geological survey or Bureau de Recherches Géologiques et Minières – BRGM from France).

This project will focus on development of a scientific strategy for dealing with PFAS, knowledge transfer in the field of analysis and (bio)remediation of emerging pollutants through development of new approaches for PFAS remediation. The expected impact of PFAStwin is to enhance the reputation, research and administrative profile, and networking channels of UBFC and improve its capability to compete successfully for national, EU, and international research funding while simultaneously benefiting partner institutions through new contacts, skills, and collaborations.

Keywords: PFAS, remediation, scientific strategy, knowledge transfer

TWINNING FOR SMART WATER - THINKING AND RETHINKING WASTEWATER MANAGEMENT IN CIRCULAR ECONOMY FRAME (SmartWaterTwin)

Djurdja V. Kerkez

Department of Chemistry, Biochemistry and Environmental Protection, Faculty of Sciences, University of Novi Sad, Trg Dositeja Obradovica 3, 21000 Novi Sad, djurdja.kerkez@dh.uns.ac.rs

The Green Agenda for the Western Balkans, through its pillars, addresses the initiatives to support the region in developing circular economy (CE) strategies and fighting pollution of air, water and soil. Driven by increased demands in water, energy and food, and simultaneously with the necessity to reduce environmental impact, water treatment sector urges for innovative solutions. According to this wastewater can potentially contribute to the nexus of water, energy and material recovery, with regard to the circular-economy design. The SmartWaterTwin project aims to boost knowledge and research excellence in the area of sustainable wastewater treatment and management by increasing the scientific and technical capacities of widening institution. In the long run SmartWaterTwin will initiate the paradigm shifting from linear (traditional) toward circular (future) model in water sector in the Republic of Serbia. In addition, it will serve as “soft instrument” for assessment the boundary conditions for circularity by influencing knowledge levels, collaboration and policy creation. Analysis assessment for the potential benefits of the circular economy for the Republic of Serbia will be performed, and can be extrapolated for Western Balkan region. Indicators measuring performance towards the development of CE is competitiveness and innovation, which will be unleashed throughout the project objectives. The project will provide an opportunity for twinning in a coherent international approach to the circular economy through developing a comparative analysis from two perspectives - "thinking and rethinking" of circular-economy in the water sector. The project will change the perception of wastewater - do not think about the waste but about the source.

Keywords: wastewater management, circular economy, energy, resource recovery, smart cities

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CROPINNO
STEPPING UP SCIENTIFIC EXCELLENCE AND INNOVATION CAPACITY FOR CLIMATE-RESILIENT CROP IMPROVEMENT AND PRODUCTION

Dragana Miladinović**, Ankica Kondić-Špika, Tijana Zeremski, Sandra Cvejić, Sonja Gvozdenac, Boško Dedić, Siniša Jocić, Aleksandra Radanović, Ana Marjanović-Jeromela, Vuk Đorđević, Marina Tomičić, Goran Bekavac, Sonja Tančić-Živanov, Milan Mirosavljević, Jelena Ovuka, Milan Jocković, Nada Hladni, Biljana Kiprovski, Sanja Mikić, Dragana Trkulja, Svetlana Glogovac, Vladimir Miklič, Nenad Dušanić, Velimir Radić, Nada Grahovac, Dragana Rajković, Nemanja Ćuk, Verica Takač, Miloš Krstić, Jelena Jocković, Jegor Miladinović

*Institute of Field and Vegetable Crops, National Institute of Republic of Serbia, Maksima Gorkog 30, 21000 Novi Sad, Serbia, *dragana.miladinovic@ifvcns.ns.ac.rs*

Twinning project CROPINNO establishes collaboration network between Institute of Field and Vegetable Crops (IFVCNS), Novi Sad, Serbia and internationally-recognized research institutions from Spain (CSIC-IAS, Cordoba), Italy (UNIPD, Padova), and Germany (FZJ, Juelich and UROS, Rostock). Its main objective is to step up and stimulate scientific excellence and innovation capacity of IFVCNS in the field of climate-smart crop improvement and production and enhance its ability to respond and create innovative solutions for the challenges that agriculture faces - climate changes and need to feed the increasing population. The other CROPINNO objectives are strengthening of the research management and administration skills of the IFVCNS and creating the conditions for positioning of IFVCNS as a regional hub of R&I in the area of agriculture and creation of Climate Crops Centre. These objectives will be achieved through a set of training, networking and dissemination activities, including short-term scientific missions, workshops, international summer schools, national and international conferences, as well as Field days.

The expected impacts of CROPPINO include improved excellence capacity, enhanced strategic networking activities, raised reputation, research profile and attractiveness of IFVCNS and the research profile of its staff, strengthened research management capacities and administrative skills of IFVCNS staff, as well as improved creativity supported by the development of new research activities and collaborations and increased mobility of qualified scientists.

Keywords: Climate, Resilience, Crops, Capacity Building

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OPPORTUNITIES AND CHALLENGES FOR MEMBRANE SEPARATION PROCESS INTENSIFICATION

***Szabolcs Kertész*[1*], Gabriella Huszár[1], Balázs Szegedi[2], József R. Lennert[3], József Csanádi[4], Nikolett Sz. Gulyás[4], Zsuzsanna László[1], Gábor Veréb[1], Sándor Beszédes[1], Cecilia Hodúr[1]**

[1] *Department of Biosystems Engineering, Faculty of Engineering, University of Szeged, Moszkvai krt. 9., H-6725 Szeged, Hungary, *kertesz@mk.u-szeged.hu*

[2] *Department of Mechanical Engineering, Faculty of Engineering, University of Szeged, Mars tér 7., H-6724 Szeged, Hungary*

[3] *Department of Materials Science and Technology, Audi Hungaria Faculty of Automotive Engineering, Széchenyi István University, Egyetem Tér 1., H-9026 Győr, Hungary*

[4] *Department of Food Engineering, Faculty of Engineering, University of Szeged, Moszkvai krt. 5-7., H-6725 Szeged, Hungary*

The dairy industry produces a large amount of wastewater due to the high water consumption of technological operations, cleaning and washing. Membrane separation processes are promising methods for efficient wastewater treatment. However, the main disadvantage of membrane techniques is the membrane fouling, which can be reduced by increasing the shear rate on the surface of the membrane, i.e. by changing the hydrodynamics flow conditions in the module by vibration, or using 3D printed promoters integrated into module.

The scope of our research is the detailed examination of the membrane separation processes by testing a batch and a cross-flow type equipment configuration for membrane fouling decreasing. Ultrafiltration experiments were carried out with a Millipore stirred ultrafiltration cell and a laboratory scale vibrating membrane separation vibratory shear enhanced processing equipment with 50 and 150 kDa cut off polyethersulfone membranes. Eight different 3D printed promoters were designed, printed and compared, then two were selected for further measurements. Cura software and a Creality CR-10S Pro V2 3D printer were used. Promoters were made from Polylactic Acid material, printed by Fused Deposition Modelling technique using 0.2 mm layer thickness with 100% infill density, at 215°C printing and 60°C bed temperature.

Permeate fluxes, retention and reversible and irreversible resistance values were compared with varying operational parameters, with and without promoter. The stirring at a high velocity, module vibration and 3D printed promoter had increased the efficiency of ultrafiltration, resulted higher permeate flux values and lower resistance values. On one hand, from the results with module vibration it can be concluded that it could increase the permeate flux five times and could decrease the total resistances by 80%. On the other hand the selected node type promoter could increase the permeate flux three times and could decrease the total resistances by 70%.

Keywords: membrane separation, ultrafiltration, membrane fouling decreasing, module integrated 3D printed promoter

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ANALYSIS OF CEC_S IN THE ENVIRONMENT OF WESTERN BALKANS

Jelena Živančev**, Igor Antić, Maja Buljovčić, Dušan Rakić, Nataša Đurišić-Mladenović

University of Novi Sad, Faculty of Technology Novi Sad, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia,
**jelena.zivancev@tf.uns.ac.rs*

New contaminants of emerging concerns (CECs) are unregulated synthetic or natural chemicals, including but not limited to pharmaceuticals, personal care products, illicit drugs, and hormones, whose presence in environmental resources increasingly attracting the academic and public attention especially in the last decade, due to their potential adverse effects on human health and the environment. Developed countries and the EU Member States are using new analytical approaches based on advanced analytical techniques for wide-range CECs surveillance in environmental resources, enabling gathering of new information important for future control measures towards zero pollution environment. In contrast, in the Western Balkans (WBs) region, information on the wide-range CECs occurrence (except those primarily relating to pollutants listed in the Water Framework Directive (WFD)) is very scarce and limited in terms of the number of measured compounds and the geographical distribution of the sampling points. This presentation examines the available studies dealing with the occurrence of CECs in the WBs' environmental resources and defines the gaps and inconsistencies related to their presence, revealing the current chemical (CECs) status of the environment in this region. The absence of extensive and permanent campaigns that would provide a wide base of reliable data is the main issue that hinders the comprehensive assessment of the CECs distribution in the WBs' environmental resources and imposes the need to apply new advanced analytical methodologies for a wide-range CECs surveillance. This presentation also gives an overview of analytical protocols for the wide-range CECs analysis based on green extraction technologies, which enables overcoming the obstacle related to different physico-chemical properties of various CECs, allowing analysis of these contaminants at the environmental relevant level.

Keywords: Contaminants of emerging concern, CECs surveillance, WBs region, new analytical approaches

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THE DEVELOPMENT STRATEGIES FOR NANO-ENGINEERED HETEROGENEOUS CATALYSTS FOR WASTEWATER TREATMENT – TOWARDS GREENER APPROACH

Sanja Panić*, Mirjana Petronijević, Nataša Đurišić-Mladenović*

University of Novi Sad, Faculty of Technology Novi Sad, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia,
**sanjar@tf.uns.ac.rs*

The availability of clean and fresh water is a critical subject for maintaining a healthy life for humans and wildlife. Contaminants of emerging concern (CECs) represent natural or manmade chemicals and materials ranging from pharmaceutical products to organic industry pollutants that are continuously released into the environment, but are not the subject of routine monitoring or emission control, while their impact of the environment and health is potentially negative. Since CECs have been detected in both wastewater effluent and drinking water, they have become a global issue in recent decades. Conventional water and wastewater treatment, coupled with increased industrial activities, may be inadequate to effectively remove various kinds of CECs. Therefore, a significant amount of research should be conducted on the development of advanced technologies. Among the currently used technologies, heterogeneous catalytic advanced oxidation processes (AOPs) have garnered huge response from the scientific community due to their versatile applicability, environmental friendliness, flexibility and potential cost-effectiveness. However, the design and development of appropriate catalytic materials with desirable band structure, microstructure, shape and morphology, surface area and optical properties to drive these processes remain an important challenge. Recent advances in nanotechnology have stimulated extensive research of engineered nanocatalysts with adjustable physicochemical properties for enhanced catalytic efficiency. This presentation is designed to summarize recently studied types of nanocatalysts used in AOPs with the special attention paid to the applied strategies (tuning the chemical composition, shape, and size, inducing defects, doping, noble metal nanoparticle deposition and heterojunction formation with other catalytic materials and carbon nanomaterials) used to develop high-performance nanocatalysts. Additionally, within the concept of environmental sustainability through the management of biowaste materials, some greener approaches for the fabrication of nanocatalysts will also be discussed.

Keywords: nano-engineered catalyst, development strategies, AOPs, green approach

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IMMOBILIZATION OF LIPASES ON FUNCTIONALISED CARRIERS PRODUCED FROM SELECTED AGRO-FOOD INDUSTRIAL WASTE

Sandra Budžaki[1], Zita Šereš[2], Ivica Strelec[1*]

[1] Josip Juraj Strossmayer University of Osijek, Faculty of Food Technology Osijek, Franje Kuhača 18, 31000 Osijek, Croatia, [*]ivica.strelec@ptfos.hr

[2] Faculty of Technology Novi Sad, University of Novi Sad, Bulevar Cara Lazara 1, 21000 Novi Sad, Serbia

One of the main challenges of the agro-food industry sustainable waste management by "*zero-waste*" model is the application of the circular management strategy, including development of innovative waste transformation techniques. Agro-food waste transformation into carriers for enzyme immobilization clearly represent one of such techniques, while replacement of chemical catalysts with immobilized enzymes might solve the issues of energy efficiency and environmental acceptability. On the other hand, process economic cost-effectiveness is highly dependent on the immobilized enzyme price. Whether the agro-food waste transformation could result with cost effective enzyme carriers for lipase immobilization, and subsequent development of immobilized lipases of desirable operational properties for use in the biocatalytic production, is the question this project aiming to answer. In this respect, carriers of desirable operational properties and high immobilization capacity will be prepared from selected waste: eggshells, spent coffee grounds and brown onion skin followed by subsequent immobilization of *Pseudomonas fluorescens* and *Burkholderia cepacia* lipases using various immobilization techniques. Biochemical and operational properties of free and immobilized lipases will be used for the selection of developed immobilized lipases of the greatest efficiency, which will be tested for operational functionality in the selected reactions of acidolysis, hydrolysis and transesterification. The final proof will be confirmed by industrial scale techno-economic analysis simulation, as well as life cycle analysis.

Keywords: agro-food industry waste, lipase immobilization, eggshells, spent coffee grounds, brown onion skin

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MEMBRANE PROCESSES IN WATER TREATMENT

***Nikola Maravić**, Zita Šereš, Biljana Pajin, Dragana Šoronja Simović, Nataša Đurišić-Mladenović, Jelena Šurlan*

University of Novi Sad, Faculty of Technology Novi Sad, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia,
**maravic@uns.ac.rs*

Membrane processes are increasingly used in industry, displacing conventional techniques of concentration, separation and purification. The environmental issues and reduction in energy consumption dictated by the global energy crisis drives the further development of membrane technology and corresponding industrial application. Membrane processes have numerous advantages with higher ability to control the operations, low exploitation costs and easier possibility of automation. Selectivity of membrane separation processes provided by different molecular weight cut-off (MWCO) of micro-, ultra- and nanofiltration contributed to successful water treatment applications which is nowadays irreplaceable in certain industrial sectors. Membrane separation technology application in water treatment covers a wide range of targets from particles to molecules and a wide variety of membranes which are available to the tailored separation process. Water treatment for domestic and industrial water supply include application of several membrane processes (micro-, ultra- and nanofiltration and reverse osmosis) depending on a specific type (molecular weight, shape, electric charge, hydrophilicity, etc.) of targeted compounds. Particular insight will be given in the field of nanofiltration of water samples aiming at removal of compounds of emerging concern (CECs) where the retention of such by nanofiltration membranes greatly depends on the physicochemical properties of CECs, which can be affected by solution chemistry and membranes used. Reported challenges regarding effective nanofiltration separation of CECs (non-charged, molecule geometry, etc.) will be addressed. However, with the consideration of its lower operating cost, nanofiltration could be a viable large-scale option as a barrier of CECs in successful water treatment processes.

Keywords: membrane, water treatment, nanofiltration, wastewater

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BIOMATERIALS IN WATER AND WASTEWATER TREATMENT

Vesna M. Vasić**, Dragana V. Kukić, Marina B. Šćiban

University of Novi Sad, Faculty of Technology Novi Sad, Blvd.cara Lazara 1, 21000 Novi Sad, Serbia,
**vesna.vasic@uns.ac.rs*

Biomass represents a renewable source of energy and materials that offers sustainable solutions for global challenges. It is also a source of green and sustainable materials that can maximize the pollutants' uptake efficiency from polluted water. Utilization of sustainable biomass for removal of pollutants from wastewater is vigorous technique due to its low-cost and easy availability. Any reuse of by-products or waste biomaterials increases profitability of growing raw material and reduces the costs of waste manipulation giving it higher value as secondary raw materials.

Biomass has been investigated in recent years for the removal of various pollutants (toxic substances, dyes, heavy metals, organic substances) from water and wastewaters. In the past few decades, contaminants of emerging concern (CECs) in the air, water and soil have gained significant attention due to their adverse impact on human health and the environment. CECs are highly persistent in the environment and resist the simple processes used for degradation. Although different techniques have been investigated and developed for their treatment, CECs are still pose a severe threat to human health and ecosystem. Therefore, the emphasis should be placed on new innovetive and cost-effective technologies for their remediation. This presentation will summarise the state of the art in biosorbent research, describing achivements in the field of water and wastewater treatment.

Keywords: Biomaterials, CECs, Wastewater

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ORAL PRESENTATIONS

APPLICATION OF RESPIROMETRY AND COMPREHENSIVE TWO-DIMENSIONAL GAS CHROMATOGRAPHY IN BIODEGRADATION STUDIES

***Marija B. Lješević*[1*], Branka D. Lončarević[1], Vladimir P. Beškoski[2]**

[1]*University of Belgrade, Institute of Chemistry, technology and Metallurgy, Njegoševa 12, Belgrade, Serbia, [*]marija.ljesevic@ihtm.bg.ac.rs*

[2]*University of Belgrade, Faculty of Chemistry, Studentski trg 12-16, Belgrade, Serbia*

The issue of soil, sediment and water contamination resulting from different pollutants is a great concern worldwide. According to a study called "Progress in the management of Contaminated Sites in Europe" developed by the Joint Research Center in 2014 there are about 2.5 million potentially contaminated sites of which about 14 % (340,000 sites) are estimated to be contaminated. A lot of effort is being made to find economical and efficient pollution management techniques. Bioremediation is one of them and it is a biological technology which uses various microorganisms (bacteria, fungi and some algae) capable of transforming organic pollutants into non-toxic compounds or completely mineralizing them to carbon dioxide and water. In addition to the pollution management techniques, researchers have gone to great lengths to develop new non-toxic and readily biodegradable materials to help minimize the worldwide pollution. Direct measurement respirometry and comprehensive two-dimensional gas chromatography (GCxGC-MS) are two techniques that can enhance the in depth knowledge necessary for battling the environmental pollution.

The aim of this work is to give an overview of several biodegradation experiments where respirometry and GCxGC-MS were used, and what are the advantages of each technique.

Using respirometry, the consumption/production of gases can be measured in a continuous way. During aerobic biodegradation, microorganisms can use different molecules as carbon source (such as pollutants, biodegradable polymers etc.) for growth and their metabolic processes consume O_2 and yield CO_2, which depends on species-specific characteristics, substrate type and concentration and physical attributes of the environment. Production/consumption of other gases can also be measured (CH_4, NO_2, CO, H_2, H_2S). This is very helpful in the determination of metabolic rates.

The GCxGC-MS is a powerful separation technique for the analysis of complex mixtures due to its high peak capacity and resolution compared to the conventional gas chromatography. The obtained data helps identify an extended number of metabolites, which is valuable in determining the mechanisms of degradation and metabolic pathways involved in the process.

Keywords: respirometry, GCXGC-MS

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BESPOKE PARTICLES FOR PURIFICATION AND SEPARATION MANUFACTURED VIA MEMBRANE EMULSIFICATION

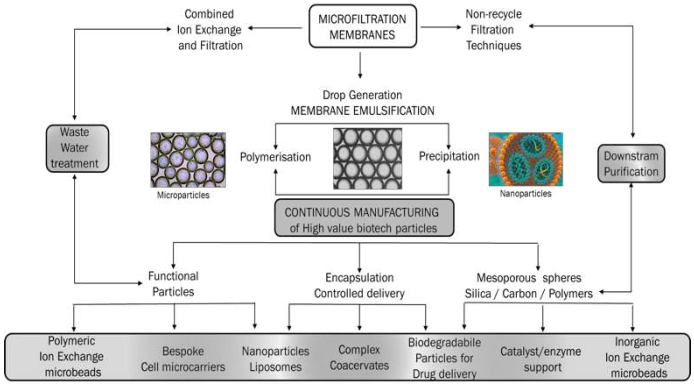
Marijana M. Dragosavac

Chemical Engineering Department, Loughborough University, Ashby Road, LE11 3TU, Loughborough, UK, m.dragosavac@lboro.ac.uk

Nowadays, resource recovery is a trending topic following the circular economy schemes proposed by the European Union. The main idea is to recover as many resources as possible from wastewater or other residues, realizing the “waste to product” concept. In this sense, adsorption and ion-exchange (IX) processes are environmental, eco-friendly, and non-expensive technologies that can achieve this aim. Adsorption and ion-exchange processes play crucial role in removal of contaminants from waste waters and are even more important in bioprocessing and downstream purification hence manufacturing right IX particles cheaply and at the right manufacturing scale is becoming very important.

Using bottom-up approach starting from a droplet, to manufacture bespoke adsorption/purification or ion exchange particles (of right size, surface area porosity and material), it would be possible to create particles for targeted removal while keeping the manufacturing costs down.

Membrane emulsification (ME) is a dispersion process to produce monosized droplets of one liquid phase (e.g. oil) in a second immiscible liquid phase (e.g. water) using low energy per unit volume where the shear stress applied on the membrane surface influences the droplet size. When ME is combined with the right down-stream processing it is possible to manufacture spherical particles of the right size, surface area and porosity fit for targeted compound removal. Up to date some of the uniform spherical particles for adsorption and ion exchange manufactured at Loughborough University include: silica, metal–organic frameworks (MOFs, ZIFs), composite, TiO_2, PVA, Agarose, Polystyrene, Chitosan, Gelatin, Alginate, Pectin. For droplets manufacturing stainless steel membranes (with straight through pores) are used in a batch and continuous membrane emulsification systems which are now commercially available through the Loughborough University Spin-out Micropore Technology Ltd.



For fast adsorption characterization of particles manufactured by ME continuous seeded microfiltration characterization method was developed. Continuous flow stirred cell was shown to be an effective technique for both mass transfer kinetics as well as equilibrium data acquisition, combining both into a single step, and simplifying ion exchange analysis. Once determined, the design parameters can readily be used to model ion exchange or adsorption in well mixed and column operations.

Keywords: ion exchange, spherical particles, membrane emulsification, seeded microfiltration

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EMERGING CONTAMINANTS IN AQUATIC ECOSYSTEM AND THEIR EFFECTS ON FISH AND HUMAN HEALTH THROUGH THE FOOD WEB

***Dragana B. Ljubojević Pelić*[1*], Nikolina J. Novakov[2], Brankica D. Kartalović[1], Jelena M. Vranešević[1], Miloš M. Pelić[1], Željko A. Mihaljev[1], Milica M. Živkov Baloš[1]**

[1]*Scientific Veterinary Institute, Rumenački put 20, 21000 Novi Sad, Serbia, [*]dragana@niv.ns.ac.rs*

[2]*Faculty of Agriculture, Trg Dositeja Obradovića 8, 21000 Novi Sad, Serbia*

Emerged contaminants have increased worldwide seriously over the past few decades and it is currently recognized as a serious threat to aquatic ecosystem and consequently to human health. They can be ingested by aquatic organisms from various trophic levels and transferred through the food web. The present paper summarizes current knowledge related to occurrence of emerging contaminants in aquatic ecosystem and their potential risk for human health. The use of fish in human nutrition is highly recommended and it is known that fish represents a valuable source of all nutrients. However, consumers are increasingly directing their attention towards safety requirements associated with fish consumption due to the presence of various contaminants. Fish from polluted aquatic ecosystem can contain different harmful substances with negative effects on human health, such as heavy metals, antibiotic resistant bacteria, pesticides, antibiotics and hormones and can lead to the spread of jaundice, diarrhea, dysentery and other infectious diseases.. Anthropogenic activities including agricultural practices, industrialization, mining and urbanization can cause pollution of aquatic environment. Also, the existing practice in aquaculture can lead to increased concentration of pathogenic bacteria, antibiotic resistant bacteria, parasites, viruses, antibiotic residues, heavy metals, persistent organic pollutants, radionuclides. People employed at aquaculture facilities, people living near these facilities and other aquatic ecosystems and consumers of the fish are specific populations at risk of exposure to various emerged contaminants. Additional studies are required in order to understand the health risks associated with fish consumption and to develop suitable measures for reduction or prevention of human health risks. Continuous monitoring of the presence and concentration of different contaminants in aquatic environment and fish is very important, having in mind that fish is an important food source but also is also an important indicator of environmental contamination. Research should provide important data for the exposure assessment part of risk assessments for contaminants from fish and aquatic ecosystem.

Keywords: pollution, aquaculture, food chain, fish, anthropogenic activities

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USE OF PURIFIED WASTEWATER FROM SLAUGHTERHOUSE AND FARM INDUSTRIES IN AQUACULTURE AND AGRICULTURE

***Nikolina J. Novakov*[1*], Brankica D. Kartalović[2], Dragana B. Ljubojević Pelić[2], Jelena M. Vranešević[2], Miloš M. Pelić[2]**

[1]*Faculty of Agriculture, Trg Dositeja Obradovića 8, 21000 Novi Sad, Serbia, [*]nikolina@polj.uns.ac.rs*

[2]*Scientific Veterinary Institute, Rumenački put 20, 21000 Novi Sad, Serbia*

In the environmental sector, the requirements in sustainability and environmental protection have been never higher. An increasing number of pollutants are significantly endangering the environment and technologies that allow reduction of pollution represent a significant contribution to the conservation of the environment. Further, the use and reuse of purified water in several production systems, its quantity saving, makes a contribution to the preservation of this resource. Since the fresh water poses a limited resource it should be used in all industries and agriculture as rationally as possible. The largest number of facilities in the slaughterhouse industry releases low treated water into the sewerage system and the channel network, adversely affecting all natural waters. The wastewater of the slaughterhouse industry carries with it feces, straw, unprocessed fodder, various gastric secretions, blood, fats, various solid wastes and other present organic substances. Many applied technological solutions to prevent endangerment of natural recipients have not given adequate results from the environmental aspect. Recently, the efficiency of wastewater treatment has been considered by applying the model of an integrated slaughter system with a fish pond, and agriculture production. Wastewater from the slaughterhouse industry or farms can be purified through separators, clarifiers, pre fish pond and aerators, and as such be ready for further use in aquaculture and agriculture production. Also, the temperature of water after using it in warm-water aquaculture production is more suitable for irrigation systems than well water. Fish produced in this system besides economic benefits serve as a bioindicator of the environment, and is suitable as a food for human consumption. The fishery area improves the environmental conditions of the slaughterhouse industrial facility. The application of this technology guarantees safe wastewater treatment and rational fishery and agriculture production using water of appropriate temperature and quality.

Keywords: wastewater, purification, aquaculture, agriculture

POSTER PRESENTATIONS

ANALYSIS OF BIODEGRADATION PRODUCTS FROM BIOPLASTICS BY LC-HRMS

Katerina Savva, Maria Fernandez-Altimira, Maria Vila, Marinella Farré, Marta Llorca*

*IDAEA-CSIC, Jordi Girona 18-26; 08034-Barcelona, Spain, *marta.llorca@idaea.csic.es*

The global market for bioplastics is increasing continuously because of the high demand for eco-friendly products (consumers and brands alike), the stronger support from governmental agencies and policies to impulse a sustainable bioeconomy, and the continuous efforts of the bioplastics industry to develop novel materials with improved properties and new functionalities [1]. Innovative biopolymers such as PLA (polylactic acid) and PHAs (polyhydroxyalkanoates) are the most used bioplastics due to their versatility, which makes them an ideal replacement for several conventional fossil-based plastics. However, most commercial bioplastics require some treatment before they can be efficiently removed from the media. Nonetheless, these processes serve just for at least 90% of the bioplastic while the rest will reach microscopic size once discharged in the environment [2]. Those biomicroplastics (bioMPLs) could persist in the environment if their optimum biodegradation conditions are not reached (temperature, pH, bacteria, fungi, etc.). Therefore, these bioMPLs could behave like conventional plastics with the added drawback of a future decomposition in (bio)monomers faster than fuel-based plastics. The (bio)degradation of these polymers could cause some harmful effects to (micro)organisms so it is important to investigate all these aspects. The main objective of this work has been to investigate the biodegradation of two selected bioplastics (PLA and PHB) and two commonly used consumer products made of these polymers (PHB - plastic bags and PLA-single use knives). All the materials have been exposed in marine microcosms for two months emulating controlled Mediterranean conditions. Samples were taken weekly, purified and concentrated by a solid-phase extraction procedure and, finally, analyzed by means of liquid chromatography coupled to high resolution mass spectrometry equipped with an electrospray ionization source working in negative and positive, separately [3]. All the data was acquired in full scan and data dependent scan modes, in parallel, at a resolution of 70,000 FWHM. The raw data has been processed by Compound Discoverer 3.0, where more than 15,000 tentative compounds or interesting masses (m/z) have been spotted. These results have been manually refined reducing the tentative identification to less than 500 compounds.

After two weeks of exposure, the results showed the lixiviation of bioplastic additives such as phthalates and adipates, which are commonly introduced into bioplastics formulation to improve their mechanical properties and persistence. Comparing consumer products, plastic bags made of PHB degraded faster than PLA knives. These results agree with the chemical results, where additives were found more frequently in PHB microcosms than in PLA ones. These findings support the need to further investigate the effects of biopolymers, bioplastics, their degradation products and their additives, not only in biota but also in the whole water column.

Keywords: Bioplastics, Biodegration, marine microcosmos, LC-HRMS

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SYNTHESIS AND CHARACTERIZATION OF MAGNETITE-BIOCHAR COMPOSITE AS A POTENTIAL ADSORBENT FOR WASTEWATER TREATMENT

***Mirjana Petronijević*[1*], Sanja Panić[1], Saša Savić[2], Sanja Petrović[2], Nataša Đurišić-Mladenović[1]**

[1]*University of Novi Sad, Faculty of Technology Novi Sad, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia,*
[*]*mirjana.petronijević@uns.ac.rs*

[2]*University of Niš, Faculty of Technology, Bulevar Oslobođenja 124, 16000 Leskovac, Serbia*

The biochar is a porous carbon material which has proven to be good eco-friendly adsorbent for the removal of organic pollutants. Its exceptional properties (large specific surface area, high porosity, etc.) provide various opportunities for its application. Also, the surface of biochar can be designed by different procedures of chemical modification/functionalization: treatment with acids, bases or enrichment with other metals, all in order to tailor its properties for specific application. The application of magnetite particles has received huge attention in recent years due to their separation properties. Magnetite-biochar composites have the combination of adsorption properties of biochar and magnetic properties of magnetite. In this work the synthesis of magnetite-biochar composite followed by its characterization was investigated. The synthesized composite was characterized using XRD, SEM/EDS and BET method. The possibility of iron ions leaching from the composite is determined by ICP-OES method.

The magnetite-biochar composite was synthesized from Fe (II) and Fe (III) sulfate salts and biochar in one step by alkali co-precipitation method at 80°C. The presence of magnetite in composite was confirmed by XRD analysis, while the SEM/EDS analysis revealed the heterogeneous surface of the sample with the following elemental composition: C (64 wt%), O (23 wt%), Fe (9 wt%) and Na (4 wt%). Additionally, the obtained composite is portrayed by relatively high specific surface area (73.5 m^2/g) and low total pore volume of the meso- and small macropores (0.04 cm^3/g). On the other hand, the high volume of the large macropores in the range 2.4-5.6 μm indicates that the porosity of the prepared composite is primarily determined by the presence of these pores. The results of leaching test proved the stability of the composite since no presence of any iron ions was detected in the solution. Taking into account the obtained characterization results it can be presumed that this material has a good potential for application as adsorbent in wastewater treatment processes.

Keywords: Magnetite-biochar composite, Characterization, Leaching test, Adsorbent

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APPLICABILITY OF LIFE CYCLE IMPACT ASSESSMENT METHODOLOGIES: DESIGN OF NATURE BASED SOLUTIONS FOR WATER DECONTAMINATION

Sanja Radovic*[1*], Maja Turk Sekulic[1], Sabolc Pap[1,2], Boris Agarski[1], Djordje Vukelic[1], Jelena Radonic[1], Jelena Prodanovic[3]

[1]Department of Environmental Engineering and Occupational Safety and Health, Faculty of Technical Sciences, University of Novi Sad, Trg Dositeja Obradovića 6, 21 000 Novi Sad, Serbia, [*]sanjaradovic@uns.ac.rs

[2]Environmental Research Institute, UHI North Highland, University of the Highlands and Islands, Thurso, Caithness, Scotland, KW14 7JD, UK;

[3]Faculty of Technology in Novi Sad, University of Novi Sad, Bulevar cara Lazara 1, 21 000 Novi Sad, Serbia

In modern world with exponential growth of industry and threat of resources depletion, designing more sustainable processes and products are of great importance. Hence, implementation of analytical tools which will lead towards mentioned goal is beneficial in earliest stages of product/process design. Life cycle assesment methodology has been widely used as a support, analytical tool in different area of research including environmental engineering. It provides an environmental profile of certain process or a product within its whole ("cradle to grave") or within only specific parts of its life cycle (e.g. "gate-to-gate", "gate-to-grave", "wheel-to-wheel"). Present work includes life cycle assessment of the novel, bio-based coagulant production process from raw material (common bean seeds) to the final product (powdered coagulant suitable for wastewater treatment). Among several steps of production (including mechanical processing of raw material, extraction and drying process) the drying step showed the highest environmental impact through all observed impact categories, which was also considered as one of the main novelties and findings of the study. The drying process utilised in this research was spray drying process which operates on high temperatures (120°C in this study). In total, three kind of coagulant production processes were evaluated in order to determine one which is the most ecologically acceptable. It was observed that difference between extractions types did not hindered the results significantly. On the other hand, addition of preserving chemicals or carrier materials (e.g. gum Arabic) during spray drying process significantly decreased environmental impact (for around 50%) by reducing the amount of raw material needed for the production of the same amount of final product. The results were based on declared unit of 1 kg. However, in order to gain more representative picture of differently produced coagulant performances, coagulation-flocculation tests were performed. All coagulants achieved significant turbidity removal in tested model water (over 55 and up to 68.3%), but on different optimal dosages, which should not be neglected while choosing the right coagulant for further use in real systems. In the end, it should be noted that some of the instruments used in the study were of half-industrial scale and experiments were done in lab-conditions, hence, further optimisation could be conducted. Furthermore, due to coagulant's high performances and simple design of production process with very low chemical consumption, novel bio-based coagulant could be considered as worthy possible solution in wastewater treatment systems, which could replace commercially used, potentially hazardous coagulants.

Keywords: Life cycle assessment, Natural solutions, Wastewater treatment

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IS THERE A SHARP DIFFERENCE BETWEEN THE DEFINITIONS "COMPOUNDS OF EMERGING CONCERNS" AND "ENDOCRINE-DISRUPTING COMPOUNDS"?

Igor Antić, Jelena Živančev, Maja Buljovčić, Dušan Rakić, Nataša Đurišić-Mladenović*

*University of Novi Sad, Faculty of Technology Novi Sad, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia, *antic@tf.uns.ac.rs*

The aim of this work was to review the frequently used definitions for "compounds of emerging concerns (CECs)" and "endocrine-disrupting compounds (EDCs)" in order to reveal the main difference in the substances and/or classes of substances covered by mentioned terms. Even though terminology can vary sometimes, generally CECs comprise three large groups of compounds (*i*) substances that have been introduced into the environment recently, e.g., new synthetic industrial compounds; (ii) compounds known for a longer time as present in the environment (e.g., hormones), but not before identified as potentially dangerous to the environmental health and/or humans; and (iii) substances that have been identified using the latest analytical techniques, in spite of being present in the environment for years. EDCs are exogenous agents that interfere with the "synthesis, secretion, transport, binding, action, or elimination of natural hormones in the body" (USEPA definition) with the ability to block or imitate the natural hormones responsible for the functioning of some organs of the body. CECs include pharmaceutically active compounds (PhACs), naturally and synthetically occurring hormones, personal care products (PCPs), plant protection products, disinfection by-products (DBPs), industrial and household chemicals, heavy metals (As, Pb, Cd, Hg), *etc*. Although CECs have been known to occur in the environment for years, it is only in the past decade that health and environmental concerns have been linked to these substances and have been brought to the cutting edge of the scientific, regulatory, and environmental communities. It is worth mentioning that CECs are currently not regulated (not submitted to a routine monitoring and/or emission control regime), but may be under surveillance for future regulation, e.g., Watch List. All of the compounds belonging to the CECs can be classified as suspected endocrine disruptors until enough proof of the endocrine-disrupting properties of a particular substance and/or class of substances is well-documented, when it is classified as EDC, and it stays in this group of EDCs "forever". Hence, the main difference between CECs and EDCs is that CECs remain "emerging" as long as there is a scarcity of information in the scientific literature or there are poorly documented issues about the associated potential problems they could cause.

Keywords: Contaminants of emerging concern, Definitions, Endocrine-disrupting compounds

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OCCURRENCE AND FATE OF PHARMACEUTICALS IN SPANISH INTERMITTENT STREAMS

***Olga Gómez-Navarro**, Nicola Montemurro, Sandra Pérez*

*IDAEA-CSIC, C/ Jordi Girona 18-26, 08034 Barcelona, Spain, *ognqam@cid.csic.es*

Intermittent streams are defined by seasonal flooding and drying, where climate and geomorphic characteristics have a direct influence on structural and functional features. At the same time, effluents from industrial and municipal wastewater treatment plants (WWTPs) are a continuous source of contamination. Intermittent streams usually receive an important contribution of these effluents, sometimes even accounting for the totality of the flow, especially during dry seasons or in cases of very low flow rates. In these cases, streams can be directly dominated by the wastewater effluent. Consequently, contaminants of emerging concern, among these pharmaceuticals, can be detected in surface water at concentrations up to µg/L. Their release can imply environmental persistence and may even induce unintended effects on non-target organisms. Hence, the determination of these compounds in the environment is essential to characterize the quality of surface water and the changes that can undergo during the different weather seasons. In this study, the aim is to evaluate the effect of different WWTP effluents along the watercourse of intermittent streams in Spain. Grabbed samples from six different wastewater effluent dominated streams from Osona, a region in Catalonia (Spain) were collected. Different points along the streams were sampled; upstream, the WWTP discharge point and several downstream points in order to study the possible natural attenuation. Samples were extracted by means of a solid phase extraction procedure using a homemade multilayer mixed-bed cartridge containing a mixture of four different sorbents with different selectivity (Oasis HLB, WCX, WAX, Bond Elut PPL) to cover a wide range of polarities. Over 100 pharmaceuticals selected based on their occurrence and ubiquity in the aquatic environment were screened using high-resolution mass spectrometry Q-Exactive Orbitrap. For the separation of the analytes, liquid chromatography was performed using Acquity UPLC HSS T3 column (100x2.1mm, 1.8 µm). After an initial screening, the presence of over 50 pharmaceuticals, including acetaminophen, carbamazepine, diclofenac, losartan, sulfamethoxazole, venlafaxine, between others, were detected and quantified. The clear impact of the WWTP at the discharge points can be observed in all cases and how the general concentration tendency is to decrease along the river. This can be due to a dilution effect or the presence of natural attenuation such as photo-degradation or biodegradation.

Keywords: *Intermittent Streams, Pharmaceuticals, Attenuation, Fate*

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PRESENCE OF CECs IN CROPS AFTER IRRIGATION WITH CONTAMINATED WATER USING HRMS

***Nicola Montemurro**, Sandra Perez Solsona*

ONHEALTH Dept. of Environmental Chemistry, IDAEA-CSIC, Jordi Girona 19-26 08034 Barcelona, Spain,
**nmoqam@cid.csic.es*

The current scarcity of water is afflicting several countries both in the Mediterranean basin and in the arid or semi-arid areas of the entire globe. As a consequence, the demand for the use of wastewater for irrigation of crops is constantly increasing, mainly due to the need for food to feed the entire world population. In the Mediterranean region, characterized by frequent periods of drought, the reuse of wastewater for irrigation of vegetable crops is regularly applied. However, it is recognized that wastewater treatment plants are unable to completely remove organic contaminants (especially drugs) from wastewater effluents. Consequently, wastewater can become an important vehicle for contaminants of emerging concern (CECs) that can be taken up by crops and, subsequently, can enter the food web with potential health implications. The present work aimed to evaluate the distribution and the bioaccumulation of more than 40 relevant CECs, mainly pharmaceuticals in widely consumed vegetable crops such as lettuce and radish grown under controlled conditions and soil samples.

Lettuce and radish plants were grown in pots in a controlled environment and irrigated during the w growing period (60 days for lettuce and 25 days for radish) with spiked tap water containing the target compounds at low and high concentrations (10 and 100 ng mL^{-1}, respectively). The high spiking level was used to facilitate the detection and quantitation of the target compounds and their metabolites in all tissues. Another set of plants was irrigated with real wastewater to study the impact of contaminants at real environmental concentrations. Control plants were irrigated only with tap water.

CECs in lettuce and radish tissues were extracted by using two different modified QuEChERS methods whereas the detection was performed using a compact hybrid quadrupole time-of-flight mass spectrometer with accurate mass.

Sixteen compounds were positively determined in crop tissues. Preliminary results reveal the presence of all analytes in crop tissues and soil samples irrigated with spiked water at high concentration. Carbamazepine presents the highest accumulation in crop tissues (leaves and roots). Conversely, crop plants irrigated with treated wastewater presented no significant level of contamination.

Keywords: Pharmaceuticals, crop uptake, translocation, water reuse, lab-scale study

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BLACKBERRY STEM LIGNIN AS A BIOSORBENT FOR REMOVAL OF Cr(VI) IONS FROM WASTEWATER

***Vesna M. Vasić*[1*], Dragana V. Kukić[1], Marina B. Šćiban[1], Mirjana G. Antov[1], Jorge Gominho[2], Ana Lourenço[2], Ricardo A. Costa[2], Duarte M. Neiva[2,3]**

[1]*University of Novi Sad, Faculty of Technology Novi Sad, Blvd. cara Lazara 1, 21000 Novi Sad, Serbia, [*]vesna.vasic@uns.ac.rs*

[2]*Centro de Estudos Florestais-CEF, Instituto Superior de Agronomia, Universidade de Lisboa, Tapada da Ajuda, 1349-17 Lisboa, Portugal*

[3]*Centro de Ecologia Aplicada "Prof. Baeta Neves"-CEABN, Instituto Superior de Agronomia, Universidade de Lisboa, Tapada da Ajuda, 1349-17 Lisboa, Portugal*

Lignin is one of the most important components of lignocellulosic materials and, in terms of quantity, the second most abundant material in nature. It is most often obtained from black liquor, a waste product from the paper industry, which is generally burned in order to obtain energy, while only 5% of the available lignin is used for other purposes. In recent years, lignin has attracted the attention of scientists due to its good physical, chemical and antioxidative properties. With the appropriate treatments, it can be transformed into valuable products such as adhesives, binders, polyurethane foams, epoxy resins, etc. Considering its three-dimensional structure and a large number of different functional groups, it could be used for the purification of wastewater with increased concentrations of heavy metals. This paper addresses the possible use of lignin, isolated from blackberry stems, as a biosorbent for the removal of Cr(VI) ions from wastewater.

Batch experiments were performed by mixing 0,1 g of adsorbent and 100 ml chromium solution (initial concentration 50 mg/l and pH 2) for 5 min to 24 h. The kinetic study demonstrated fast adsorption during the first several hours while reaching equilibrium took more than 24h. After 24 h, 94.4% of the total adsorbed amount of Cr(VI) was removed from the solution at an initial concentration of about 50 mg/l. Equilibrium studies showed that the Langmuir model appeared to be the best for fitting experimental data with the q_{max} of 303.03 mg/g and R^2=0.9964. It can be concluded that lignin isolated from blackberry stems is a promising material for the removal of Cr(VI) ions from wastewater.

Keywords: Lignin, Biosorbent, Blackberry, Chromium, Wastewater

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MICROPLASTICS AS A VECTOR OF POLLUTION WITH PERSISTENT ORGANIC POLLUTANTS

***Brankica D. Kartalovic*[1*], Jelena M. Vranešević[1], Dušan S. Lazic[1], Nikolina J. Novakov[2], Krešimir M. Mastanjević[3], Kristina J. Habschied[3]**

[1]*Scientific Veterinary Institute Novi Sad, Rumenacki put 20, Novi Sad, Serbia, *brankica@niv.ns.ac.rs*

[2]*Department of Veterinary Medicine, Faculty of Agriculture, University of Novi Sad , Novi Sad, Serbia*

[3]*Faculty of Food Technology, Josip Juraj Strossmayer University of Osijek, Osijek, Croatia*

Microplastics are persistent environmental pollutants, with plastic particles smaller than 5 mm. In the time of global contamination with microplastics, when parts of microplastics are found almost everywhere on Earth, polluting water, soil, air as well as plants, animals and people it is necessary to determine the types of pollutants that bioaccumulate through microplastics in living organisms of the observed ecosystem.
Studies have shown that microplastics act as pollution vectors by sorbing persistent organic pollutants (pah, ocp, pcb), contributing to the bioaccumulation of pollutants, especially in aquatic ecosystems, because pollutants present in aquatic media tend to be distributed between the aqueous and solid phases, so as well as between the water phase and microplastics. In support of this fact are the results obtained at the Scientific Veterinary Institute in the period from 2019-2022, when the concentrations of pesticides, polychlorinated biphenyls and Polycyclic aromatic hydrocarbons were detected in marine samples of fish and shells. Concentrations of organic pollutants, determined by the method of gas chromatography with mass detection, were less than allowed, but still alarming considering that they were found in marine organisms. Based on the knowledge about microplastics obtained worldwide, the aim is to continue the studies started by monitoring the presence of microplastics and organic pollutants in marine organisms, in order to determine the risk of sorption and bioaccumulation of microplastics by animals, and to determine the presence of dominant types of pollutants sorbed by microplastics and types of pollutants that microplastics bioaccumulate in living organisms of the observed ecosystem.

Keywords: microplastics, pollution, ecosystem

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WATER REGULATIONS, TREATMENT OF INDUSTRIAL WASTEWATER AND PROBLEMS IN PRACTICE

***Žužana Šandor Milošević*[1*], Nelli Molnar[2]**
[1]*Ljiljak doo, Petra Drapšina 1, 23000 Zrenjanin, Serbia, *ljiljakzuzana@gmail.com*
[2]*Servo Mihalj Elementary School, Magyarske Komune 55, 23206 Zrenjanin, Serbia*

During their operation, many industrial plants generate wastewater that is difficult to purify and require special technology. The causes of large wastewater quantities are, on the one hand, the continuous increase of the number of inhabitants on Earth, and on the other, the intensive development of the process industry. At the same time, an ever-increasing amount of various wastes and pollutants is releasing to the environment. The mentioned causes have opened up many problems related to land, water, air, and biosphere pollution.
The economy is obliged to obey all legislations in the field of water resources management, to do monitoring, to report to the competent authority and to follow emission limit values.
According to law on waters, in order to ensure a unified water regime and achieve water management, water acts are issued, and the water permit is the result of the established regime.
The acts are issued in the process of preparing technical documentation: - for the construction of new, upgrade and reconstruction of existing facilities of the complex; - for the performance of other works that may permanently, occasionally or temporarily affect the change in the water regime; - for the construction of planning documents.
The issue of wastewater treatment is very complex and is one of the limiting factors in the further development of humanity. There has been a level of global interest in the field of both municipal and industrial wastewater treatment.
Wastewater from industry differs from one to another in terms of quality and quantity due to different production technologies and ways of water utilization. In order to successfully treat industrial wastewater biologically, chemically and mechanically, the following purification treatments have to be applied: coagulation/flocculation, precipitation with the addition of iron and aluminum salts, filtration on single-media and dual-media filters, adsorption on granulated active coal, as well as oxidation using stronger oxidizing agents in the so called Advanced Oxidation Processes (AOPs) leading to oxidation/mineralization of organic molecules under atmospheric conditions.
It is therefore necessary to eliminate or reduce the causes of pollution, reduce the quantity of harmful substances and take measures in order to return the polluted water after the treatment back into the system.
After the treatment, the solid part of the waste from the water, if there are no harmful substances, is further used in agriculture. If there are harmful substances, the sludge has to be further treated.

Keywords: wastewater, water act, wastewater treatment

PAHs ORIGINATING FROM TRADITIONAL SMOKEHOUSES AND THEIR EFFECT ON ENVIRONMENT AND HUMAN HEALTH

Jelena M. Vranešević*[1*], Brankica D. Kartalović[1], Nikolina J. Novakov[2], Snezana Škaljac[3], Suzana L. Vidaković Knežević[1], Miloš M. Pelić[1], Dragana B. Ljubojević Pelić[1]

[1]*Scientific Veterinary Institute "Novi Sad", Rumenački put 20, 21000 Novi Sad, Republic of Serbia, [*]jelenababic@niv.ns.ac.rs*

[2]*Department of Veterinary Medicine, Faculty of Agriculture, University of Novi Sad, Trg Dositeja Obradovića 8, 21101 Novi Sad, Republic of Serbia*

[3]*Department of Food Preservation Engineering, Faculty of Technology, University of Novi Sad, Bulevar cara Lazara 1, 21000 Novi Sad, Republic of Serbia*

When we talk about the Republic of Serbia and its traditional meat products, we first of all think of pork products, smoked in traditional or homemade manufacture smokehouses. The results of our tests show that products smoked in this way have values of PAH compounds much higher than products smoked in industrial conditions. According to the Regulation of the EU Commission (2020/1255) of 7th September, 2020, it was established that despite the application of good production practices during smoking, it is impossible to achieve lower amounts of PAHs in certain cases of traditionally smoked meat and smoked meat products. PAHs are introduced into the environment via natural and anthropogenic combustion processes, with the fact that anthropogenic activities have dramatically increased the quantity of PAHs in the environment. PAHs are considered to be carcinogens and their distribution in the environment and possible exposures to humans have been the focus of much attention. Concern is how much PAHs pollution is present in environment around traditional smoke chambers, and how this pollution affects people which are in charge meat smoking process.

Keywords: Polycyclic aromatic hydrocarbons, carcinogens

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APPLICATION OF ORGANIC ACTIVATED BENTONITE IN THE TREATMENT OF AMMONIA-PHENOL WASTEWATER

Hana Alihodžić, Abdel Đozić, Melisa Ahmetović*, Indira Šestan, Sabina Begić, Mirnesa Zohorović, Halid Junuzović

Faculty of Technology, Urfeta Vejzagića br. 8, 75 000 Tuzla, Bosnia and Herzegovina,
**melisa.ahmetovic@untz.ba*

Industrial wastewater generated in various stages of the technological process of production of coke, benzene, ammonium sulfate is directed and purified in a biological treatment plant. This type of wastewater contains high concentrations of phenol, ammonia, cyanide and rhodanide. Quaternary ammonium cation (hexadecyltrimethylammonium bromide, HDAM) was used for bentonite activation. The highest measured concentration of phenol was 674.4 mg/L and the lowest was 571.2 mg/L. The average value after treatment with activated bentonite was 448.4 mg/L, i.e. the removal efficiency was 28%. The average concentration of ammonia during the research period was 53.1 mg/L, the average value after treatment was 43.8 mg/L. The amount of bentonite used removed an average of 9.3 mg/L. The removal efficiency was 17.5%. Rhodanide concentration ranged from 211.5 mg/L to a maximum of 290 mg/L, the average value was 268.9 mg/L. After treatment with bentonite, the average value in the waste water was 160.2 mg/L. The removal efficiency was 40.4%. Activated bentonite showed the lowest absorption efficiency in the treatment of cyanide, the efficiency was 11%. The maximum measured concentration of cyanide was 3.6 mg/L and the lowest was 3.2 mg/L, which shows the relative uniformity in the concentration of cyanide in waste water.

Keywords: bentonite, activation, adsorption, ammonia-phenol wastewater

APPLICATION OF RAW BENTONITE IN THE TREATMENT OF AMMONIA-PHENOL WASTEWATER

Abdel Đozić, Hana Alihodžić, Halid Junuzović*, Indira Šestan, Sabina Begić, Mirnesa Zohorović, Melisa Ahmetović

Faculty of Technology Tuzla, Urfeta Vejzagića br. 8, 75 000 Tuzla, Bosnia and Herzegovina,
**halid.j@hotmail.com*

In the technological process of ammonium sulfate production, ammonia-phenol wastewater is produced, which contains high concentrations of phenol, ammonia, cyanide and rhodanide. This type of wastewater is most often treated conventionally in plants for biological wastewater treatment, which is not satisfactory when it comes to removing high concentrations of ammonia and cyanide. The paper examines the possibility of using bentonite in the purification of ammonia-phenol wastewater, using the adsorption process. Raw bentonite without the addition of activator was used, and the influence on the concentration of ammonia, phenol, cyanide and rhodanide was tested. Experimental data showed that bentonite is a good adsorbing material, the concentration of total ammonia was reduced by 10 mg/L, or by 20%. The decrease in phenol concentration was in the range of 3-13 mg/L, with the average concentration in the sample treated with bentonite being about 8 mg/L. Bentonite showed no affinity for the adsorption of cyanide and rhodanide ions. The optimal amount of bentonite used for adsorption was 0.5 g/100 mL of wastewater.

Keywords: raw bentonite, adsorption, ammonia-phenol wastewater

LIST OF PARTICIPANTS

Last name First name:		Affiliation, City, Country	E-mail:
1.	Ahmetović Melisa	Faculty of Technology, Tuzla, Bosnia and Herzegovina	melisa.ahmetovic@untz.ba
2.	Antić Igor	University of Novi Sad, Faculty of Technology Novi Sad, Novi Sad, Serbia	antic@tf.uns.ac.rs
3.	Basarin Biljana	University of Novi Sad, Faculty of Sciences, Department of Geography, Tourism and Hotel Management, Novi Sad, Serbia	biljana.basarin@gmail.com, biljana.basarin@dgt.uns.ac.rs
4.	Begić Sabina	Faculty of Technology, Tuzla, Bosnia and Herzegovina	sabina.begic@untz.ba
5.	Beškoski Vladimir	University of Belgrade, Faculty of Chemistry, Belgrade, Serbia	vbeskoski@chem.bg.ac.rs
6.	Buljovčić Maja	University of Novi Sad, Faculty of Technology Novi Sad, Novi Sad, Serbia	majab@tf.uns.ac.rs
7.	Crespo João	LAQV-Requimte, Department of Chemistry, FCT - NOVA University of Lisbon, Portugal	jgc@fct.unl.pt
8.	Dragosavac Marijana	Chemical Engineering Department, Loughborough University, UK	m.dragosavac@lboro.ac.uk
9.	Đurišić-Mladenović Nataša	University of Novi Sad, Faculty of Technology Novi Sad, Novi Sad, Serbia	natasa.mladenovic@uns.ac.rs
10.	Farré Marinella	ON HEALTH research group, Institute of Environmental Assessment and Water Research (IDAEA-CSIC), Barcelona, Catalonia, Spain	mfuqam@cid.csic.es
11.	Gómez-Navarro Olga	ON HEALTH research group, Institute of Environmental Assessment and Water Research (IDAEA-CSIC), Barcelona, Catalonia, Spain	ognqam@cid.csic.es
12.	Gominho Jorge	Centro de Estudos Florestais-CEF, Instituto Superior de Agronomia, Universidade de Lisboa, Portugal	jgominho@isa.ulisboa.pt
13.	Junuzović Halid	Faculty of Technology, Tuzla, Bosnia and Herzegovina	halid.j@hotmail.com
14.	Kartalovic Brankica	Scientific Veterinary Institute Novi Sad, Novi Sad, Serbia	brankica@niv.ns.ac.rs
15.	Kerkez Djurdja	Department of Chemistry, Biochemistry and Environmental Protection, Faculty of Sciences, University of Novi Sad, Novi Sad, Serbia	djurdja.kerkez@dh.uns.ac.rs

16.	Kertész Szabolcs	Department of Biosystems Engineering, Faculty of Engineering, University of Szeged, Szeged, Hungary	kertesz@mk.u-szeged.hu
17.	Kukić Dragana	University of Novi Sad, Faculty of Technology Novi Sad, Novi Sad, Serbia	dkukic@uns.ac.rs
18.	Llorca Marta	ON HEALTH research group, Institute of Environmental Assessment and Water Research (IDAEA-CSIC), Barcelona, Catalonia, Spain	marta.llorca@idaea.csic.es
19.	Lončarević Ivana	University of Novi Sad, Faculty of Technology Novi Sad, Novi Sad, Serbia	ivana.radujko@tf.uns.ac.rs
20.	Lourenço Ana	Centro de Estudos Florestais-CEF, Instituto Superior de Agronomia, Universidade de Lisboa, Portugal	analourenco@isa.ulisboa.pt
21.	Lješević Marija	University of Belgrade, Institute of Chemistry, technology and Metallurgy, Belgrade, Serbia	marija.ljesevic@ihtm.bg.ac.rs
22.	Ljubojević Pelić Dragana	Scientific Veterinary Institute, Novi Sad, Serbia	dragana@niv.ns.ac.rs
23.	Maletić Snežana	University of Novi Sad, Faculty of Science, Novi Sad, Serbia	snezana.maletic@dh.uns.ac.rs
24.	Maravić Nikola	University of Novi Sad, Faculty of Technology Novi Sad, Novi Sad, Serbia	maravic@uns.ac.rs
25.	Miladinović Dragana	Institute of Field and Vegetable Crops, National Institute of Republic of Serbia, Novi Sad, Serbia	dragana.miladinovic@ifvcns.ns.ac.rs
26.	Montemurro Nicola	ON HEALTH research group, Institute of Environmental Assessment and Water Research (IDAEA-CSIC), Barcelona, Catalonia, Spain	nmoqam@cid.csic.es
27.	Nikolić Ivana	University of Novi Sad, Faculty of Technology Novi Sad, Novi Sad, Serbia	ivananikolic@uns.ac.rs
28.	Nikolovski Branislava	University of Novi Sad, Faculty of Technology Novi Sad, Novi Sad, Serbia	barjakb@uns.ac.rs
29.	Novakov Nikolina	Faculty of Agriculture, Novi Sad, Serbia	nikolina@polj.uns.ac.rs
30.	Odobašić Amra	Faculty of Technology, Tuzla, Bosnia and Herzegovina	92minhen95@gmail.com
31.	Pajin Biljana	University of Novi Sad, Faculty of Technology Novi Sad, Novi Sad, Serbia	pajinb@tf.uns.ac.rs

32.	Panić Sanja	University of Novi Sad, Faculty of Technology Novi Sad, Novi Sad, Serbia	sanjar@tf.uns.ac.rs
33.	Pérez Sandra	ON HEALTH research group, Institute of Environmental Assessment and Water Research (IDAEA-CSIC), Barcelona, Catalonia, Spain	spsqam@idaea.csic.es
34.	Petronijević Mirjana	University of Novi Sad, Faculty of Technology Novi Sad, Novi Sad, Serbia	mirjana.petronijević@uns.ac.rs
35.	Petrović Jovana	University of Novi Sad, Faculty of Technology Novi Sad, Novi Sad, Serbia	jovana@tf.uns.ac.rs
36.	Radovic Sanja	Department of Environmental Engineering and Occupational Safety and Health, Faculty of Technical Sciences, University of Novi Sad, Novi Sad, Serbia	sanjaradovic@uns.ac.rs
37.	Rakić Dušan	University of Novi Sad, Faculty of Technology Novi Sad, Novi Sad, Serbia	dusan.rakic.1995@gmail.com
38.	Strelec Ivica	Josip Juraj Strossmayer University of Osijek, Faculty of Food Technology Osijek, Osijek, Croatia	ivica.strelec@ptfos.hr
39.	Šandor Milošević Žužana	Ljiljak doo, Zrenjanin, Serbia	ljiljakzuzana@gmail.com
40.	Šćiban Marina	University of Novi Sad, Faculty of Technology Novi Sad, Novi Sad, Serbia	msciban@uns.ac.rs
41.	Šereš Zita	University of Novi Sad, Faculty of Technology Novi Sad, Novi Sad, Serbia	zitas@tf.uns.ac.rs
42.	Šestan Indira	Faculty of Technology, Tuzla, Bosnia and Herzegovina	indira.sestan@untz.ba
43.	Šurlan Jelena	University of Novi Sad, Faculty of Technology Novi Sad, Novi Sad, Serbia	jelena.surlan@uns.ac.rs
44.	Turk-Sekulić Maja	Faculty of Technical Sciences, University of Novi Sad, Novi Sad, Serbia	majaturk@uns.ac.rs
45.	Vasić Vesna	University of Novi Sad, Faculty of Technology Novi Sad, Novi Sad, Serbia	vesna.vasic@uns.ac.rs
46.	Vranešević Jelena	Scientific Veterinary Institute, Novi Sad, Serbia	jelenababic@niv.ns.ac.rs
47.	Živančev Jelena	University of Novi Sad, Faculty of Technology Novi Sad, Novi Sad, Serbia	jelena.zivancev@tf.uns.ac.rs

AUTHORS' INDEX

About TwiNSol-CECs Project

TwiNSol-CECs will generate the collaborative environment required for University of Novi Sad, Faculty of Technology Novi Sad (TFNS), Serbia, to increase and implement its research in the field of CONTAMINANTS OF EMERGING CONCERN (CECs). This will be accomplished by twinning under Horizon Europe programme with two EU research intensive institutions with strong expertise in the field:

- Spanish National Research Council, Institute of Environmental Assessment and Water Research (CSIC), Barcelona, Spain, and
- NOVA University Lisbon, NOVA School of Science and Technology (UNL), Lisbon, Portugal,

which eminent researchers will help TFNS to unlock the scientific potential through intensive networking, transfer of knowledge and technical expertise.

Surveillance of CECs and improvement of the removal technologies have important role in protection of humans and the environmental resources. Such efforts are in compliance with the European Green Deal (EGD) commitment for transition of EU to zero-pollution, toxic free environment. They are also in line with the 2030 Agenda for Sustainable Development. Preserving the quality of water, air, and soil, protecting the drinking water sources, and promotion of the water protection, and pollution reduction from the source to tap, are among the priority actions of EU Strategy for the Danube Region.

TFNS recognized the Twinning Western Balkans call under HORIZON EUROPE progamme of European Union as an opportunity to reinforce own capacities already proven in innovative CECs analysis and removal methodologies and to strengthen its position in the European Resaerch Area. The project answered the call requirements, and it was evaluated with 14.5 out of 15. It started on August 01, 2022 and will last 3 years. The project maximum grant is 1 432 937.50 Euros. The full project name is “TWINNING FOR ENHANCING THE SCIENTIFIC EXCELLENCE OF FACULTY OF TECHNOLOGY NOVI SAD FOR INNOVATIVE SOLUTIONS TO PROTECT ENVIRONMENTAL RESOURCES FROM CONTAMINANTS OF EMERGING CONCERN”.

The project represents a coherent set of knowledge, skills, experience, and awareness raising activities, dissemination, communication, networking, coordination, etc. for successful achieving of the project objectives.

More about the project with the latest news on project activities and events may be found at the project web site www.twinsol-cecs.com.